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SPA, "The Stellar Photometry Assistant"

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Abstract. SPA is a stand alone software package for high speed photometry reduction and analysis. The goal of SPA is to be simple, powerful and intuitive. SPA was born out of complications studying the pulsating DB white dwarf EC20058-5234 (QuTel) due to the proximity of its companions. SPA addresses the Whole Earth Telescope's (Nather et al. 1990) demand for large scale rapid data reduction from multiple sites. SPA is being developed in MATLAB by the Delaware Asteroseismic Research Center (DARC) in collaboration with the University of Delaware and the Mount Cuba Astronomical Observatory.

1. Program Features

1.1. Simplifying the WET Pipeline

During a Whole Earth Telescope (WET) observation, incoming data is processed as quickly as possible. Rapid reduction and analysis allows the control center to efficiently allocate observing time to WET targets, and hence maximize the quality and quantity of the science. When working with images from many different acquisition systems and CCDs, problems are encountered when extracting the necessary quantities from the image sets, i.e. the Julian Day of each image. These problems are exacerbated by site specific issues, such as systematic timing errors and non-standard FITS keywords. Though the WET control center is typically manned continuously, detailed knowledge of IRAF and the reduction scripts (Kanaan et al. 2002) is often required to process problematic incoming image sets. This means that some data is not processed immediately, or excessive man-hours are required to reduce certain data sets. This hampers the ability for WET headquarters to make critical real time decisions. A goal of SPA is to alleviate these problems. SPA includes site specific scripts which, when called, pre-process the images, correct timing errors and translate non-standard FITS keywords.

1.2. Crowded Field Photometry

QuTel has been a target of seasonal observations since its discovery in the mid-1990s (Koen et al. 1995), including a WET observation (Sullivan et al. 2008). The pulsation modes of QuTel appear stable, which could allow a measurement of the rate of period change ($\dot{\mathrm{P}}$) for each mode. A measurement of $\dot{\mathrm{P}}$ could reveal information about neutrino/axion emission (Bischoff-Kim, 2008) . However, QuTel has two nearby companions, one of which lies well within efficient aperture sizes. In order to obtain precise measurements of each mode's phase, and hence $\dot{\mathrm{P}}$, along with the general goal of reducing noise, advanced data reduction techniques such as growth curve photometry (Stetson 1987) may be more suitable than synthetic aperture photometry. The modular nature of SPA allows seem-less integration of reduction techniques more powerful

than synthetic aperture photometry. Work is currently underway to incorporate growth curve photometry and various other methods involving calculation of the point spread function (PSF).

1.3. Rapid Data Reduction
Due to the time critical nature of WET reductions, and to reduce the manpower required at headquarters, the reduction algorithms of SPA are designed with speed in mind. For example, instead of reading an entire FITS frame, SPA will only read the needed sections of each image. This has decreased the time it takes to reduce an image by over an order of magnitude (for a 1024×1024 image).

1.4. Multiple Interfaces
The core of SPA lies in object oriented MATLAB classes. This encourages a modular structure, an important feature when data formatting and reduction techniques are subject to change. This also separates the user interface from the core components of the program, allowing the development of graphical user interfaces, or console interfaces without any modifications to the core code. Graphical interfaces can provide simple tools for beginner users, while the console allows complete control for more advanced users.

1.5. Open Source Development
SPA is being developed under the Academic Free License, i.e. the source code will be available. The authors, however, will discourage repackaging of the program. Instead it is suggested that any additional modules be implemented (after rigorous testing) into main branch of development. Those interested in developing SPA are encouraged to contact the authors.

1.6. Portability
SPA is compatible with R2007a and higher MATLAB releases. This means any computer, independent of operating system, can run SPA so long as MATLAB or the MATLAB component runtime can be installed. Resting on the shoulders of MATLAB is an advantage over relying on open-source software which may not be well maintained in the future. This ensures longevity, and defers system compatibility issues to the developers of MATLAB. Effort may also be taken to increase SPA's compatibility with open source MATLAB alternatives such as Octave.

2. Testing the Effectiveness of SPA
IRAF scripts developed by A. Kanaan (Kanaan et al. 2002) are being used to test the reliability and effectiveness of SPA. Synthetic aperture photometry produces similar light curves. Differences in the light curves are marginal and are likely due to variations in the methods chosen to round pixels or center an object. These tests are preliminary and a more rigorous comparison will be underway shortly.

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